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Evaluation of the Adsorption Potential of the Waterweed *Eichhornia crassipes* for Removal of Malachite Green

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ABSTRACT

In this study, Root Powder of *Eichhornia crassipes*, an abundant and freely available aquatic plant is proposed as an adsorbent for the adsorption of Malachite Green (MG) dye from aqueous solutions. The effects of the pH, adsorbent dosage, initial concentration and contact time were studied in a batch experiments at room temperature. Samples of MG after the uptake are analyzed with UV-Vis spectrophotometer. Results showed that at optimum conditions 89.5% dye removal was achieved. Thus on the basis of experimental results it can be inferred that the WHRP is an effective adsorbent for the uptake of Malachite Green from aqueous solution.

Keywords: Adsoption, Dyes, Malachite Green, Water hyacinth root powder.

1. INTRODUCTION

Dyes are a kind of organic compounds which can bring bright and firm color to other substances. Almost every industry uses coloring material to colore their products. Today there are more than 10,000 dyes available commercially[1]. The extensive use of dyes often poses pollution problems in the form of colored wastewater discharged into environmental water bodies. For some dyes, the dye concentration of less than 1 ppm in receiving water bodies is highly visible thus stated as "Visible pollutant" and even small quantities of dyes can color large water bodies. Colored effluent is also coupled with high chemical oxygen demand, biological oxygen demand and suspended solids. This not only affects aesthetic merit but also interfere the sunlight

penetration, reduces photosynthetic activity and inhibits the growth of aquatic biota. In addition, many dyes or their metabolites have effects on aquatic life and human[2]. MG is a tri-phenylmethane dye which has been used extensively for dyeing silk, wool, jute, leather, ceramic and cotton[3]. In aqua culture ,fish farming industry and animal husbandry it is used as most efficacious antifungal, antibacterial and antiparasitical theraptic agent[4]. MG and its reduced form leuco malachite green may enter into food chain and could possibly cause mutagenic, carcinogenic and teratogenic effects on human.MG has a complicated structure and it is resilient to fading on exposure to light and water and is therefore difficult to be removed from wastewater by conventional physicochemical and biological treatment methods. Adsorption technique has been proved to be an excellent way to treat dye effluent. Adsorption on activated carbon is one of the most effective adsorbent but the high cost and regeneration problem has motivated many researchers to search for alternative low cost adsorbent materials. Many materials like tree fern[5], orange peel[6], banana pith[7] date pits[8], peanut hulls[9], giant duck weed[10] teak tree bark powder[11], corn cobs and barley husk (12), rice husk and saw dust[13,14], Agave americana (L.) fibres[15] have been tested for their dye adsorption capacity. The present investigation is an attempt to explore the potential of *Eichhornia crassipes* or water hyacinth root powder (WHRP) to remove MG from wastewater.

2. MATERIALS AND METHODS

2.1 Adsorbent Preparation

Water hyacinth was collected from local river Kshipra, Ujjain. The roots of collected water hyacinth plant were separated and extensively washed with tape water to eliminate soil dust and earthy materials. Finally roots were washed several time with distilled water and sliced in pieces manually. It is then dried over night at 50^0 C in oven. The dried roots then creased sieved and stored in air tied container for further use.

2.2 Adsorbate and Chemicals

All the chemicals used in this study were of analytical grade. MG was supplied by Merck India private limited. The general characteristics of MG ($C_{23}H_{25}N_2Cl$) are molar mass = 364.63 g/mol, C.I. No.= 42000, λmax = 615 nm. Stock solution of dye was prepared by dissolving accurately weighted 1gm MG dye in 1000 ml distilled water. Latter it was diluted by using distill water according to concentration required. pH was adjusted by adding 0.1 M NaOH and 0.1 M HCl solution.

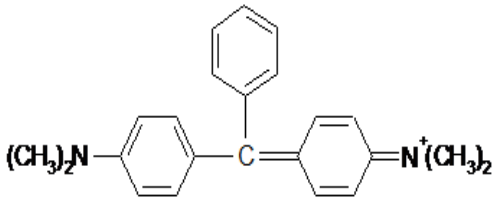

Fig.1. Structure of Malachite Green

2.3 Batch adsorption Experimentation

Batch experimentation were carried out at room temperature to study the effects of impotent parameters such as effect of pH, contact time, initial concentration and amount of adsorbent. The concentrations of MG solution before and after adsorption

were estimated by measuring absorbance at 615 nm with help of UV-visible spectrophotometer (Systronics 2105).

The percentage removal of dye is defined is the ratio of difference in dye concentration before and after adsorption ($C_0 - C_e$) to the initial concentration of the dye of the aqueous solution of the dye (C_0) and was calculated by using equation

Percentage removal = $(C_0 - C_e)\ x100/C_0$

3. RESULTS AND DISCUSSION

3.1 Effect of pH:

The interaction between dye molecule and adsorbent is basically a combined result of charges on dye molecules and the surface of the adsorbent[16]. Fig. 1 shows that adsorption of MG on WHRP increases with increasing pH.The maximum uptake of MG was observed at pH 9. At lower pH the competition of H+ ions with the cationic dye molecules due to presence of excess H+ ions decreases the adsorption[17]. As the pH of the solution increases, the number of negatively charged site increased. Strong electrostatic attraction exists between the positively charged cationic dye molecules. As a result a negatively charged surfaces on the adsorbent favours the adsorption of the dye[14]. Similar trend was reported by Hameed and Khaiary[18].

3.2 Effect of Adsorbent Dose

Adsorbent dose is representing of an important parameter due to its strong effect on the capacity of an adsorbent at given initial concentration of adsorbate. Effect of adsorbent dose on removal of MG was monitored by varying adsorbent dose from 0.1 gm/100ml to 1.0 g/100ml. The adsorption of dye increased with the adsorbent dosage and reached on equilibrium value after 0.9 g of adsorbent (fig.2). As one was accepted, percent adsorption decreased with increases in initial dye concentration, but the actual amount of dye adsorbed per unit mass of carbon increased with increases in dye concentration This means that the adsorption is highly dependent on initial concentration of dye. Similar findings were reported by Patil *et al.*[11]. This decrease in adsorption capacity with increase in adsorbent dose is mainly attributed non saturation of the adsorption sites during the adsorption process[19].

3.3 Effect of Initial Concentration and Contact Time

The effect of contact time and initial concentration (20 to 100 mg/l) of MG adsorption on to WHRP is presented in fig.3. The obtained results reveal that the uptake of adsorbate species is fast at the initial stage of the contact period, and thereafter, it becomes slower near the equilibrium. This may be due to the availability of number of vacant adsorption sites at initial stage. There was a significant decreased in percentage removal from 89.5.0% to 63.1% as initial concentration increased from 20 to 100 mg/l. At lower dye concentration, the available adsorption sites are relatively high and consequently the dye species can find easily the accessible adsorption sites[13]. However, at higher concentrations the available site of adsorption become fewer and consequently the dye ions take more time in order to reach the last available sites[15]. Furthermore, the adsorption dynamic profile shows that equilibrium has been reached in 90 minutes.

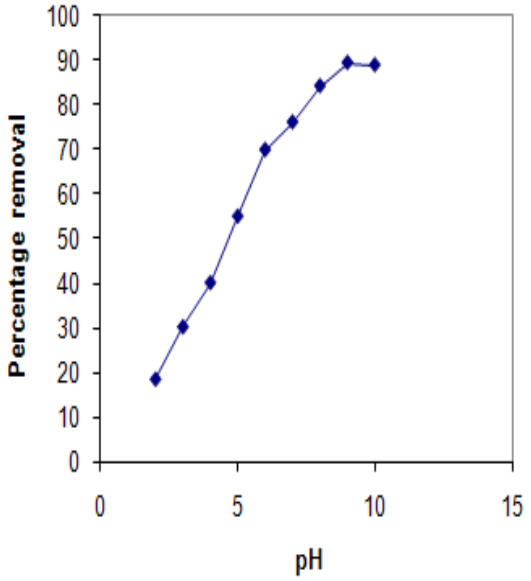

Fig.2: Effect of pH on percentage removal of MG (20mg/l) at room temperature

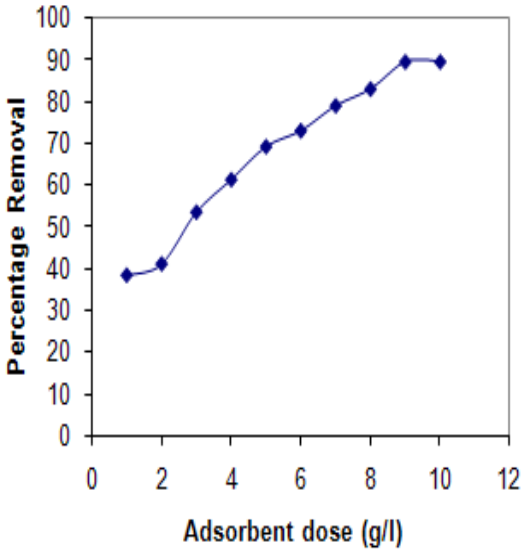

Fig.3: Effect of adsorbent dose on percentage removal of MG (Initial concentration: 20mg/l, Contact time: 90 minutes, pH 9)

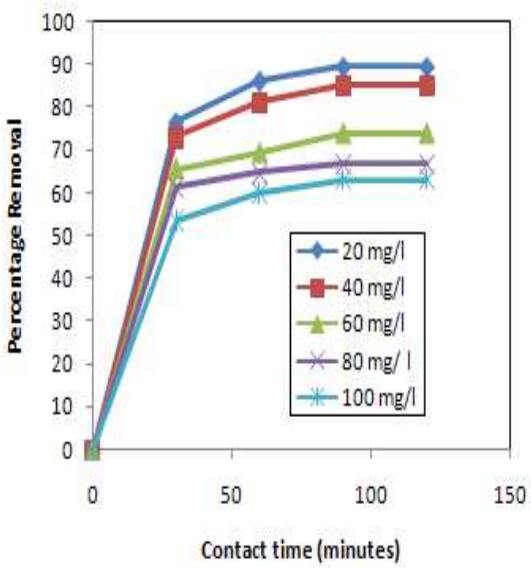

Fig.4: Effect of Initial Concentration and Contact Time on percentage removal of MG onto WHRP

4. CONCLUSION

The goal of this work is to explore the potential of WHRP as low cost adsorbent to remove MG dye from aqueous solutions. Water hyacinth is easily available waterweed in local river Kshipra. The results obtained in this study indicate the WHRP can be successfully used for the removal of hazardous dye, malachite green from aqueous solutions. The amount of dye adsorbed was found to be dependent on solution pH, adsorbent concentration, initial dye concentration and contact time. Maximum uptake of dye was observed at pH 9.The trend that the percentage of MG adsorbed increased as the adsorbent dose was increased could be seen. Under the set of optimum condition maximum 89.5% dye removal was achieved.

5. REFERENCES

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